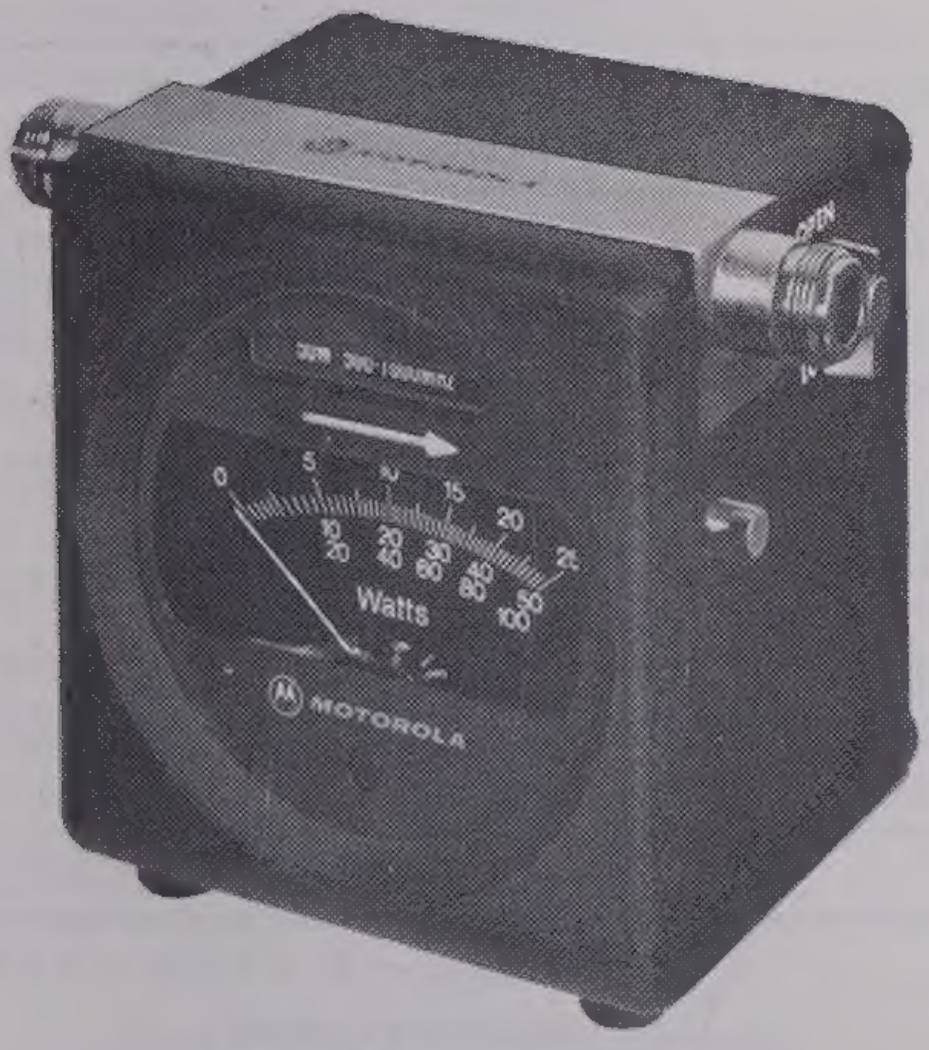
# S-1350C Wattmeter

## Instruction Manual

MOTOROLA

# S-1350C WATTMETER




technical writing services

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## SPECIFICATIONS

| | |
|---|---|
| Metering Method | Insertion type RF Wattmeter. Indicates forward or reverse power by switch operation. |
| Emissions Measured | CW or FM Carriers.<br>AM or TV at zero modulation only. |
| Frequency Range | 2 MHz to 1000 MHz with appropriate elements (see Matrix Table, page 5). |
| Power Measurement Ranges | 2.5 W to 2500 W (full scale reading) with appropriate elements |
| Accuracy | ± 5% of full scale |
| Impedance | 50 ohms |
| VSWR | 1.2:1 (max.) N type connector |
| Minimum Directivity | 20 dB |
| Connectors | N and UHF type (see Matrix Table, page 5) |
| Dimensions<br>(H x W x L) | Housing — 4" x 4-1/4" x 3-1/4" (including feet, less element)<br>Elements — 1" x 1-1/4" x 5-1/4" |
| Weight | Meter Housing: 18 oz.<br>Elements: 12 oz. |
| Temperature Range | 0° to + 70 °C |
| Humidity | 95% R.H. at 50 °C |

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# 1. EQUIPMENT FEATURES

— Measure CW or FM power.
— Measure AM or TV power at zero modulation.
— Power measurements from 2.5—2500 watts in the 2—1000 MHz range.
— Read wattage on a taut-band meter with large high resolution viewing area by simply clipping the meter housing to an in-line element.
— Low cost elements may be left in antenna or transmission lines, eliminating the need to go off-the-air when measuring power.
— Separating meter housing from element automatically damps the meter, for positive protection against mechanical shock during transit.
— Positive locking mechanism securing the element to the meter housing.
— Each element provides a wide frequency range...so fewer elements are needed to service all radio communication bands.
— Rugged, sealed elements have long trouble-free lives and cannot lose calibration.
— RF cavity and sense lines are an integral part of the element, eliminating variations in accuracy, VSWR (voltage standing wave ratio), and losses in the measurement system throughout the life of the element.
— In-line elements are designed around a bi-directional coupler concept allowing power to be measured in either direction (forward or reverse) with the flick of a switch.
— The element frequency and power label is visible through a window on the meter face so that all necessary information can be seen while taking power measurements.

# 2. WATTMETER ELEMENT MATRIX

| "N" TYPE CONNECTOR MODEL | "UHF" TYPE CONNECTOR MODEL | MAXIMUM POWER (WATTS) | FREQUENCY (MHZ) |
|---|---|---|---|
| — | ST-1296 | 250 | 2-30 |
| — | ST-1299 | 2500 | 2-30 |
| ST-1280B | ST-1281B | 5 | 25-60 |
| ST-1285B | ST-1284B | 10 | 25-60 |
| ST-1283B | ST-1282B | 5 | 50-125 |
| ST-1286B | ST-1287B | 10 | 50-125 |
| ST-1204B | ST-1244B | 25 | 25-100 |
| ST-1205B | ST-1245B | 50 | 25-100 |
| ST-1206B | ST-1246B | 100 | 25-100 |
| ST-1207B | ST-1247B | 250 | 25-100 |
| ST-1208B | ST-1248B | 500 | 25-100 |
| ST-1212B | ST-1252B | 5 | 100-250 |
| ST-1213B | ST-1253B | 10 | 100-250 |
| ST-1214B | ST-1254B | 25 | 100-250 |
| ST-1215B | ST-1255B | 50 | 100-250 |
| ST-1216B | ST-1256B | 100 | 100-250 |
| ST-1217B | ST-1257B | 250 | 100-250 |
| ST-1218B | ST-1258B | 500 | 100-250 |
| ST-1221B | ST-1261B | 2.5 | 200-550 |
| ST-1222B | ST-1262B | 5 | 200-550 |
| ST-1223B | ST-1263B | 10 | 200-550 |
| ST-1224B | ST-1264B | 25 | 200-550 |
| ST-1225B | ST-1265B | 50 | 200-550 |
| ST-1226B | ST-1266B | 100 | 200-550 |
| ST-1227B | ST-1267B | 250 | 200-550 |
| ST-1228B | ST-1268B | 500 | 200-550 |
| ST-1231B | ST-1271B | 2.5 | 500-1000 |
| ST-1232B | ST-1272B | 5 | 500-1000 |
| ST-1233B | ST-1273B | 10 | 500-1000 |
| ST-1234B | ST-1274B | 25 | 500-1000 |
| ST-1235B | ST-1275B | 50 | 500-1000 |
| ST-1236B | ST-1276B | 100 | 500-1000 |
| ST-1237B | ST-1277B | 250 | 500-1000 |
| ST-1238B | ST-1278B | 500 | 500-1000 |

# 3. GENERAL USER INFORMATION

## 3.1 DESCRIPTION

The wattmeter housing does not use the traditional rf cavity in its housing. Instead, it is a measuring system designed to accept an element which is an rf cavity and sense line combined into a single unit. This eliminates variations in accuracy, VSWR, and losses in the measuring system due to imperfect matches. The element retains rf integrity by not exposing the cavity. The meter housing makes provisions for retaining the element securely. The output of the element is picked up by three contacts in the meter housing and applied to the meter for a direct power reading. Forward and reflected power is measured by selecting the direction of the sense with a switch on the meter housing. There is no need to rotate or reconnect the element as the element is bi-directional. The transmitter or the load can be applied to either end of the element with equal performance.

The element determines the power and frequency range of the wattmeter. This information is visible on the meter face where the label on the element is displayed through a viewing window. To insure accurate readings the frequency being measured must be within the range stated for the element used. See the Wattmeter Element Matrix for a listing of available elements.

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**CAUTION**

The power range of the element must exceed the maximum power which may be transmitted through it. Otherwise, serious damage to the element, as well as to the meter, may occur, if overloaded.

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### 3.2 WATTMETER TRANSPORTABILITY

The wattmeter housing is transportable and is not designed for permanent mounting. Convenient carrying cases are available for the wattmeter housing and three elements. An accessory case holds up to twelve additional elements.

During transit, it is best to remove the plug-in element from the wattmeter. This automatically shunts the meter circuit and serves to protect the meter movement by damping the needle action. The plug-in elements should be handled with care. Although the calibration cannot be disturbed by average shock or vibration, it is best to avoid rough handling. It is not necessary to protect the wattmeter housing, when it is used indoors or within equipment, other than to prevent contaminants from touching the gold dc spring contacts.

### 3.3 PERMANENT ELEMENT INSTALLATION

In some radio equipment sites, it may be desirable to permanently install the element in the transmission line to prevent going off-the-air when measuring power. The wattmeter housing design allows it to be easily clipped to the permanently installed element when measurements are needed. Allow a minimum space of 6" x 6" x 4" around the permanently installed element for accessibility.

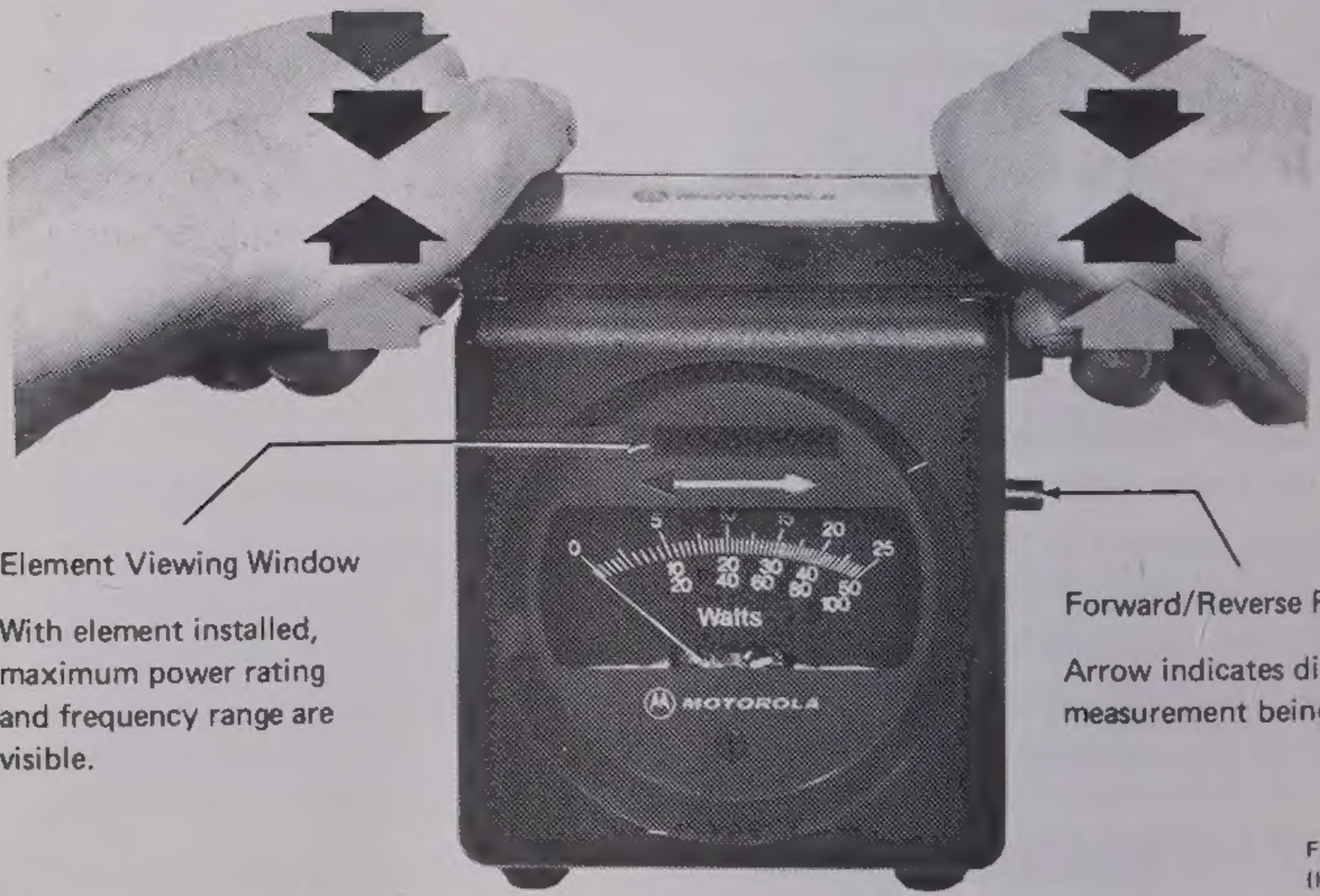
## 4. PREPARATION FOR USE

### 4.1 ELEMENT INSTALLATION AND REMOVAL

Install and remove element as shown in Figures 1 and 2, on pages 8 and 9. Locking knob must be in OPEN position when installing or removing the element.

Element Installation and Removal

Use a straight downward or upward motion, with force simultaneously applied to element ends. Don't use a rocking motion. Make sure locking knob is in OPEN position.




Element Viewing Window

With element installed, maximum power rating and frequency range are visible.

Forward/Reverse Power Switch

Arrow indicates direction of measurement being made.

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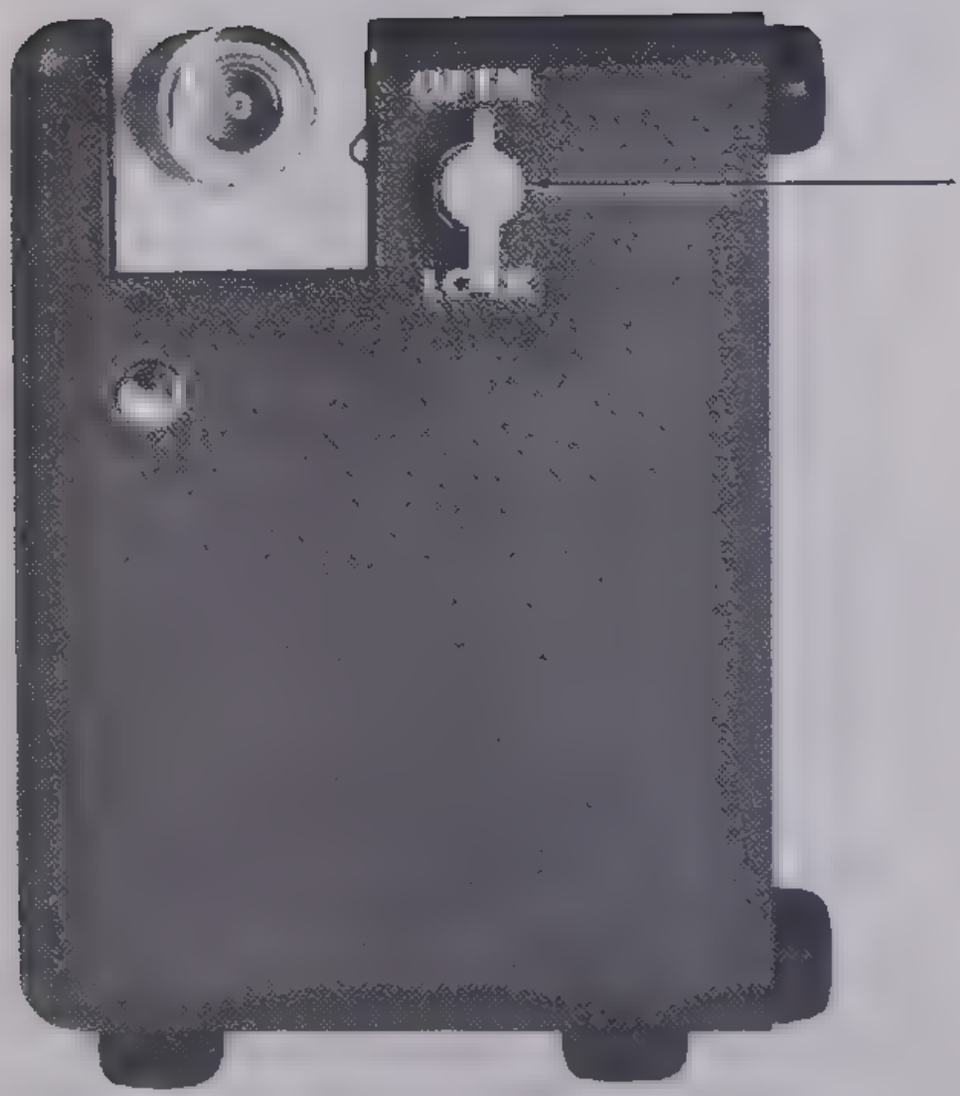
(H348)

*Figure 1. Element Installation and Removal*




Locking Knob

OPEN position applies sufficient tension to hold element in place for most applications. LOCK position applies maximum holding tension locking element in place. Use LOCK position where element is subject to vibration. Install and remove element only with knob in the OPEN position.

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(M348)

*Figure 2. Use of Locking Knob*

### 4.2 GOOD INSTALLATION PRACTICES

When using an in-line wattmeter in an rf transmission line, the following points should be considered to obtain the best results. These are especially important when working at UHF frequencies.

Point 1. Use good quality 50-ohm coaxial cable to insure minimum insertion loss and minimum VSWR. Use the shortest possible cable length.

Point 2. Elements with N-type connectors are preferred at UHF frequencies for minimum VSWR.

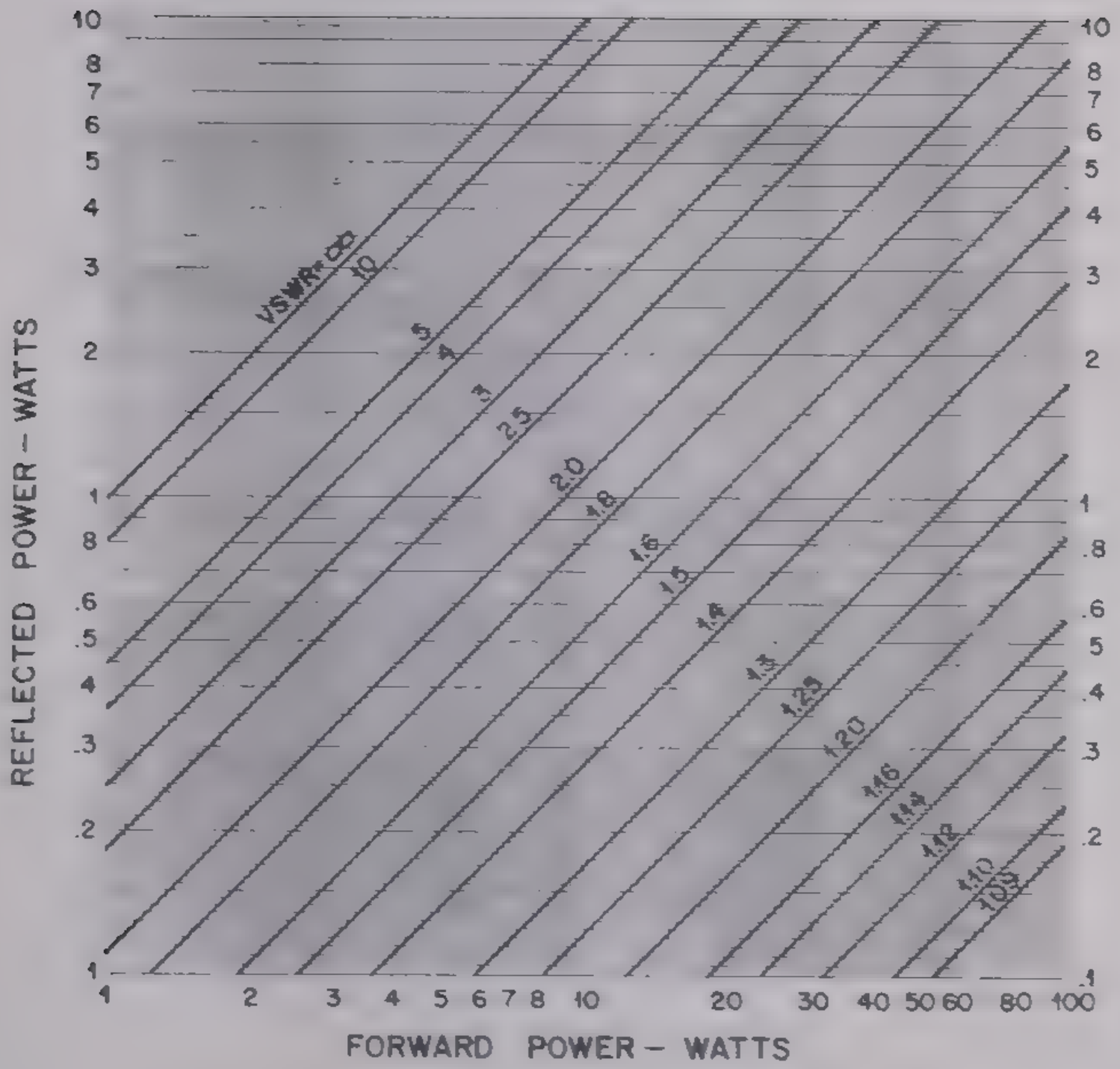
Point 3. Use the same type of connectors to match those supplied on the element: N-to-N and UHF-to-UHF. Adapters should be avoided if possible, especially at UHF frequencies.

Point 4. Exercise care that the connectors are properly installed on the cable to prevent mismatch, loss or erratic readings. Tighten all connections to the element.

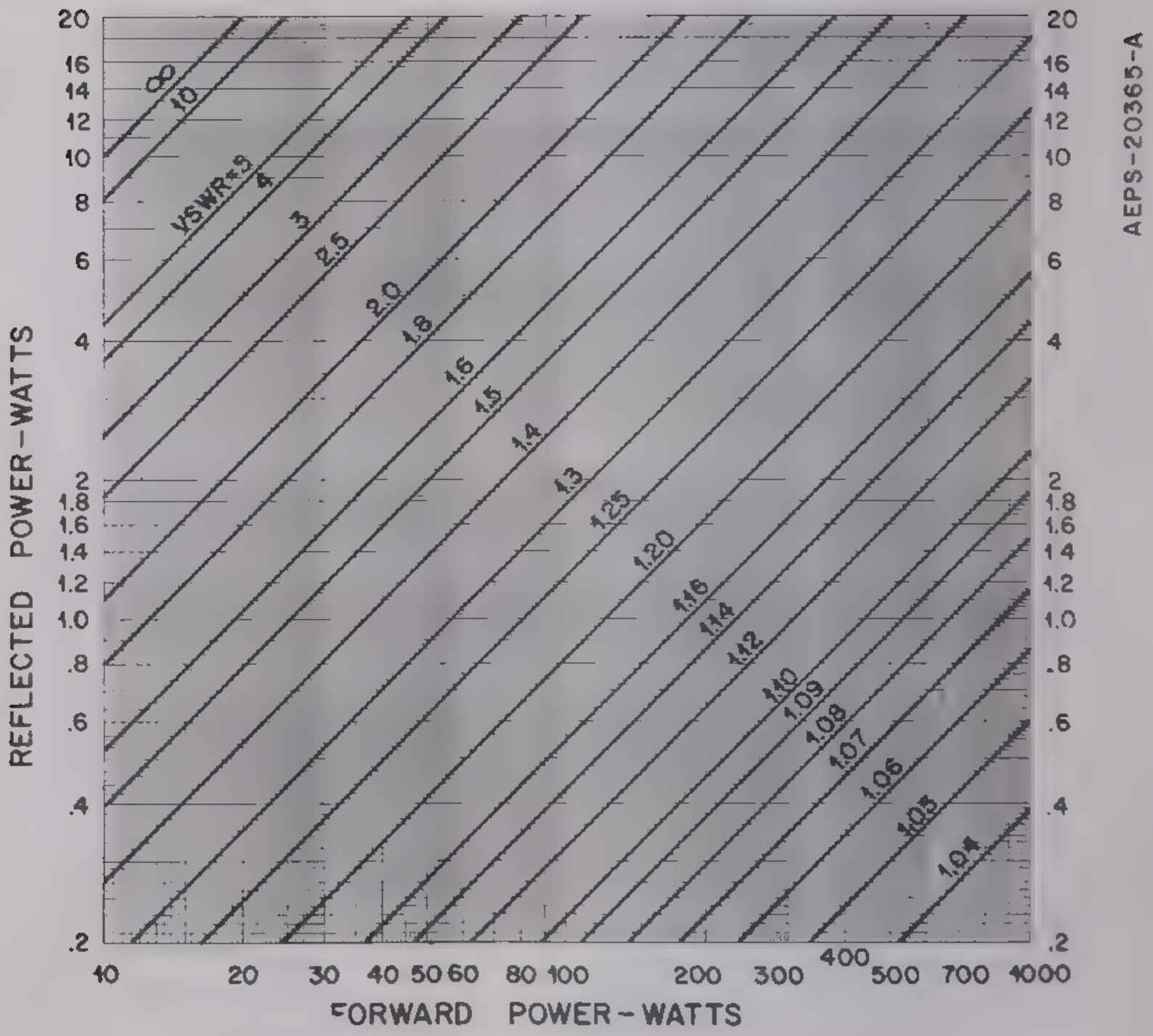
## 5. HOW TO OPTIMIZE ANTENNA POWER

The forward and reverse power reading capability of this wattmeter provides a convenient means of optimizing an antenna installation. By adjusting the load for minimum reflected power the true power delivered to a load can be maximized. The actual VSWR present in a system can be obtained from the forward and reverse power readings according to the following formula. A graphical representation of this formula is shown on Graphs 1 and 2, on pages 11 and 12.

$$\text{VSWR} = \left(1 + \sqrt{\frac{\text{Reflected Power}}{\text{Forward Power}}}\right) \div \left(1 - \sqrt{\frac{\text{Reflected Power}}{\text{Forward Power}}}\right)$$




*Graph 1. Power Values vs. VSWR*
*(1 to 100 W Forward Power)*




*Graph 2. Power Values vs. VSWR*
*(10 to 1000 W Forward Power)*

## 6. ELEMENT CARE

The element is a self-contained assembly which is non- repairable. It has been designed with the utmost consideration to durability. No recalibration is required over its lifetime. The calibration of the element will be retained even under the most severe shock and vibration. Do not allow element to be dropped because any damage to the connector threads will render the element useless. For this reason, protect the element threads with the protective end caps that are supplied with it.

If at all possible, retain the element in its protective shipping container or in the optional carrying case. Periodically, clean the gold contacts of the element to assure a clean mating surface to the meter housing.

Under no circumstances should any attempt be made to disassemble the element cavity. There are no replacement parts available for this unit as it is closely matched and assembled.

# 7. THEORY OF OPERATION

The circuitry that couples and samples the traveling waves is located in the element. Two independent couplers are used in each element, one to sense forward power, and one to sense reflected power. The meter is switched to read either output of the forward or the reverse coupler.

The cavity used in the element is a zinc casting with a cylindrical bore, through which a radiating rod is positioned, coupled to, and accurately held in place by two connector assemblies, one at each end of the element. This assembly forms a section of 50-ohm transmission line which is inserted between an rf energy source and a load (resisitive or antenna type). Because the impedance of the cavity assembly and the line section are closely matched, the VSWR is low, inserting minimal loss in the line. The element circuits are carefully selected, balanced, and compensated resulting in a minimum directivity of 20 dB.

# 8. REPLACEMENT PARTS

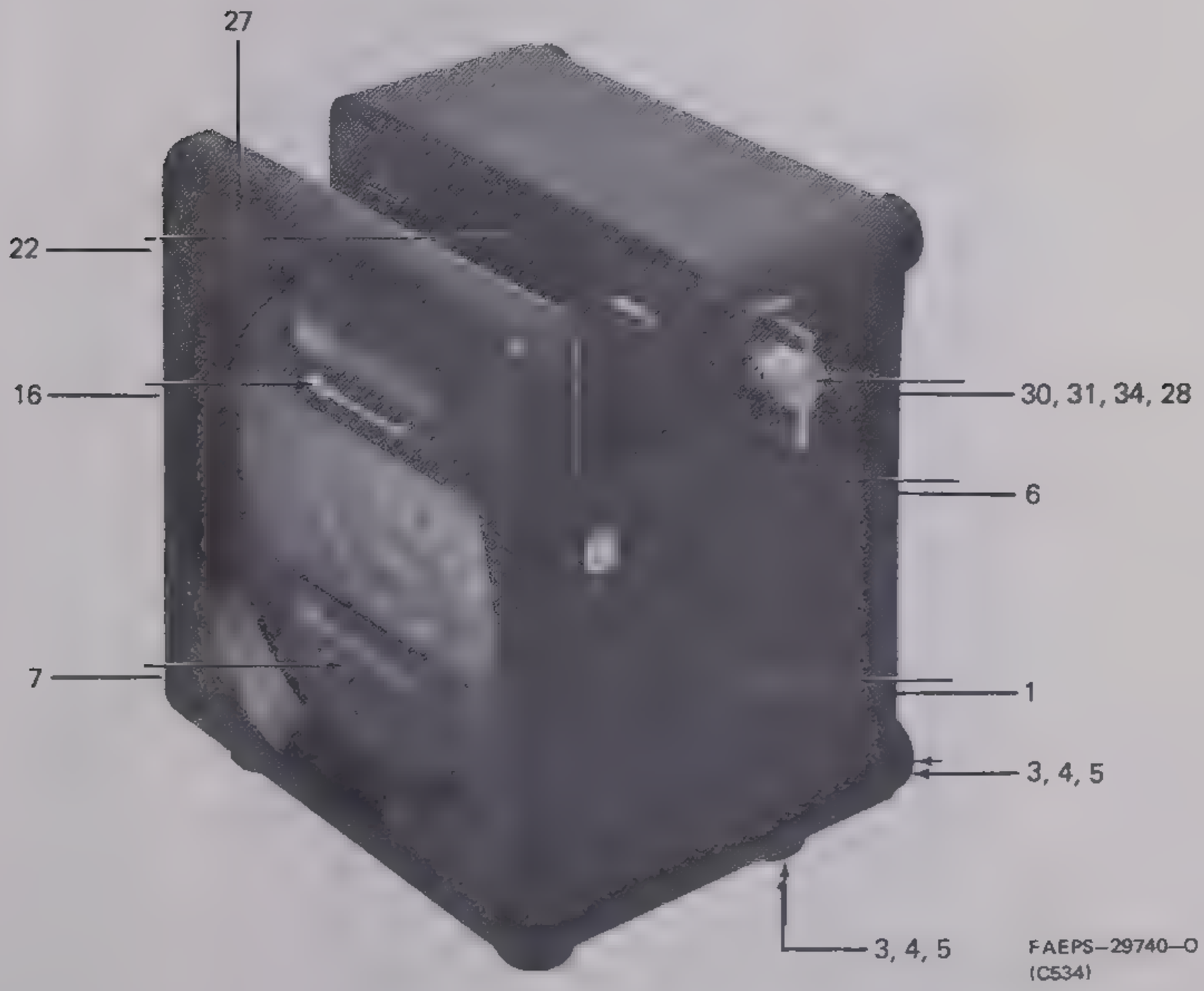



*Figure 3. Parts Location Detail (Front View)*

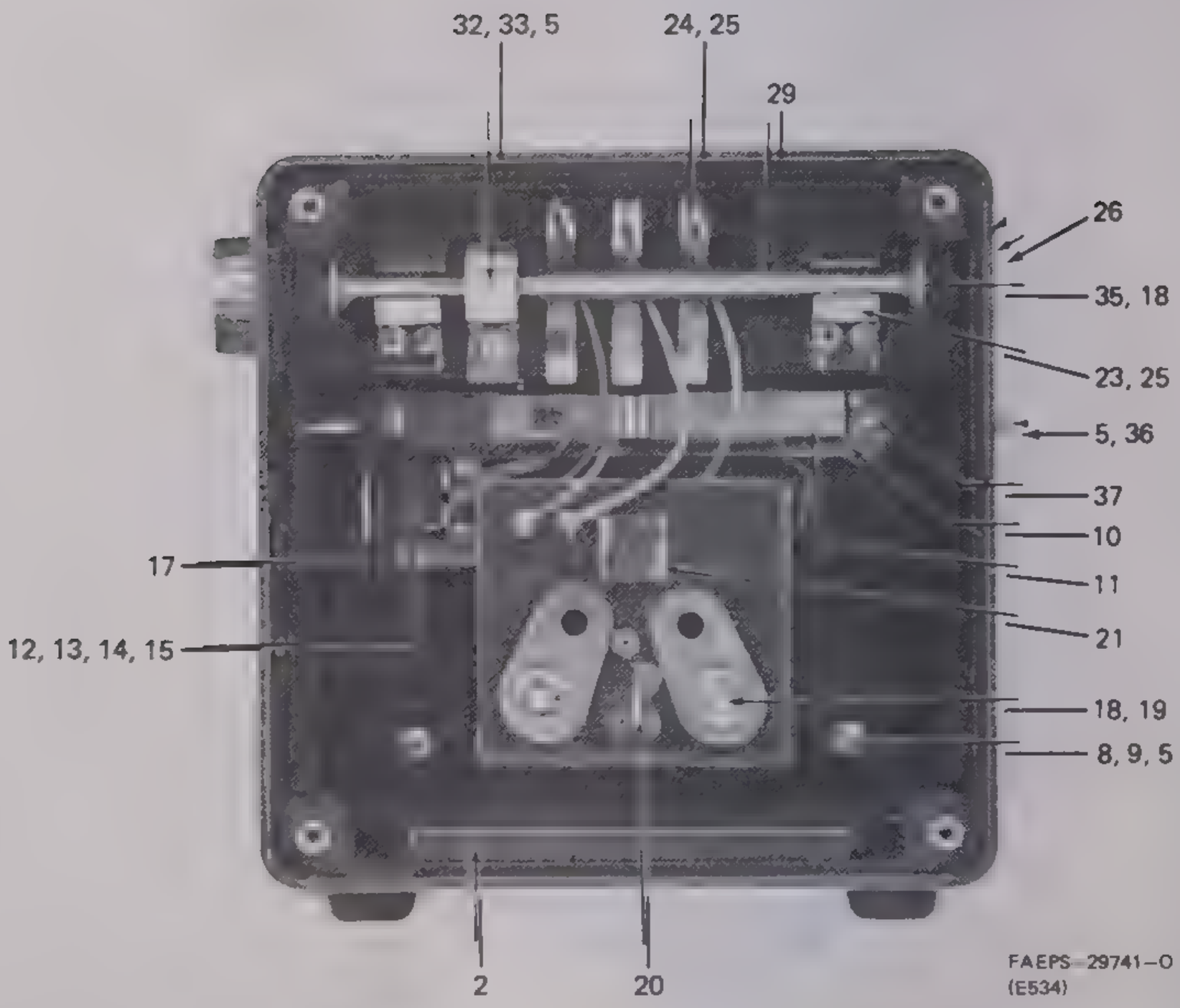



*Figure 4. Parts Location Detail (Rear View)*

| CODE NO | MOTOROLA PART NO | QUANTITY | DESCRIPTION |
|---|---|---|---|
| 1 | 15-80324A15 | 1 | Housing |
| 2 | 64-80319A74 | 1 | Ballast Plate |
| 3 | 75-82554A01 | 8 | Rubber Feet |
| 4 | 3-11483 | 8 | Screw 4-40 x 7/16" |
| 5 | 4-114563 | 12 | Lockwasher #4 Split |
| 6 | 64-80312A51 | 1 | Back Pane |
| 7 | *-80312A75 | 1 | *Meter Assembly |
| 8 | 3-139636 | 2 | Screw 4-40 x 11/16" |
| 9 | 4-7555 | 2 | Flat Washer #4 |
| 10 | 42-80336A09 | 1 | Shutter Retainer |
| 11 | 41-80336A07 | 1 | Shutter Spring |
| 12 | 40-80312A65 | 1 | Switch |
| 13 | 3-1960 | 2 | Screw 2-56 x 3/8 |
| 14 | 4-400139 | 2 | Lockwasher #2 |
| 15 | 2-704 | 2 | Hex Nut 2-56 |
| 16 | 45-80336A08 | 1 | Shutter Slide |
| 17 | 45-80320A80 | 1 | Switch Actuator |
| 18 | 4-7562 | 4 | Flat Washer #8 |
| 19 | 4-7651 | 2 | Lock Washer #8 |
| 20 | 21-865923 | 1 | Capacitor .001 uF |
| 21 | 18-83452P02 | 1 | *Potentiometer, 2k |
| 22 | 14-80324A17 | 1 | U-Channel |
| 23 | 41-80324A29 | 2 | Cavity Retainer Spring |
| 24 | 41-80312A63 | 3 | Element Contact Spring |
| 25 | 3-138195 | 10 | Screw 2 x 3/16 Self Tapping |
| 26 | 46-80324A16 | 1 | Stud |
| 27 | 3-565102 | 2 | Screw 4-40 x 3/16 |
| 28 | 46-80324A19 | 1 | Bushing |
| 29 | 47-80324A20 | 1 | Shaft |
| 30 | 36-64135H01 | 1 | Knob |
| 31 | 3-80174C02 | 1 | Set Screw |
| 32 | 41-80324A21 | 1 | Indent Spring |
| 33 | 3-131090 | 1 | Screw 4-40 x 1/4 |
| 34 | 4-706 | 1 | Flat Washer |
| 35 | 4-809779 | 2 | E Washer |
| 36 | 36-80312A60 | 2 | Button |
| 37 | 3-134243 | 2 | Screw 2-32 x 5/16 |

* Either the meter assembly or calibration potentiometer are selected when the meter must be recalibrated. Add a 6.45 mA dc to the element contact springs adjust calibration potentiometer for full scale reading.

# 9. TROUBLESHOOTING

If occasional difficulties are experienced in the use of the wattmeter, refer to the following list of symptoms and probable causes.

| Symptom | Probable Cause |
|---|---|
| No meter movement | 1. Improper connections<br>2. Element not completely inserted<br>3. Open cable between transmitter and wattmeter<br>4. Element power range is too high<br>5. Contacts touching shorting bar<br>6. Switch in reverse position<br>7. Defective forward-reverse switch<br>8. Defective or damaged meter<br>9. Defective or damaged element |
| Intermittent, inaccurate or inconsistent meter readings | 1. Improper load not matched<br>2. Poor or faulty transmission line<br>3. Dirty, corroded contacts<br>4. Intermittent shorting to the shorting bar<br>5. Sticky or loose meter |
| High VSWR | 1. Improper load<br>2. Poor connections<br>3. Shorted or open antenna |

# 10. PARTS ORDERING LOCATIONS

**NOTE**

Do not return units for servicing without prior authorization.

DOMESTIC LOCATIONS

Western Area Parts

1170 Chess Drive
San Mateo, California 94404
Phone: 415-349-8621

Southeastern Area Parts

5096 Panola Industrial Blvd.
Decatur, Georgia 30032
Phone: 404-987-2232

Midwest Area Parts

1313 E. Algonquin Road
Schaumburg, Illinois 60196
Phone: 312-576-7322

Pacific Southwestern Area Parts

9980 Carroll Canyon Road
San Diego, California 92131
Phone: 714-578-8030

Eastern Area Parts

85 Harristown Road
Glen Rock, New Jersey 07452
Phone: 201-444-9662

East Central Area Parts

12955 Snow Road
Parma, Ohio 44130
Phone: 216-433-1560

Southwestern Area Parts

3320 Belt Line Road
Dallas, Texas 75234
Phone: 214-620-8511

Mid-Atlantic Area Parts

7230 Parkway Drive
Hanover, Maryland 21076
Phone: 301-796-8763

Gulf States Area Parts

8550 Katy Freeway
Houston, Texas 77024
Phone: 713-932-9341

Rocky Mtn. States Area Parts

109 Inverness East
Englewood, Colorado 80112
Phone: 303-741-2323

National Accounts

1313 E. Algonquin Road
Schaumburg, Illinois 60196
Phone: 312-576-6512

INTERNATIONAL LOCATIONS

Canadian Parts

Canadian Motorola Electronics Company
Parts Department
3125 Steeles Avenue, East
Willowdale, Ontario
Phone: 416-499-1441

All Other Countries

International Parts
1313 E. Algonquin Road
Schaumburg, Illinois 60196
Phone: 312-576-3444

MP MASTER

MA36323

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